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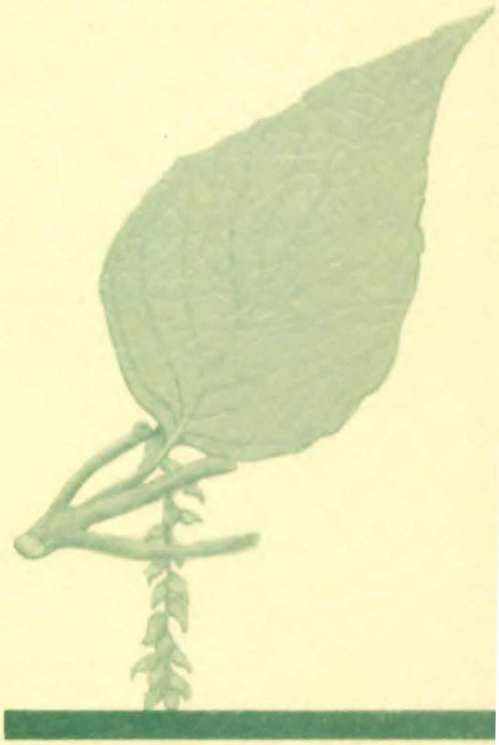
SILVICAL *Characteristics* OF...

BALSAM POPLAR

(*Populus balsamifera*)

Eugene I. Roe



LAKE STATES FOREST EXPERIMENT STATION

M. B. Dickerman, Director

FOREST SERVICE

U.S. DEPARTMENT OF AGRICULTURE

THE SILVICAL REPORTS

During 1907 and the following several years the U. S. Forest Service issued a series of silvical leaflets which covered the broad characteristics of a considerable number of major timber species. Since then much new knowledge has accumulated--some of it published in a variety of sources. There is also a considerable store of unpublished silvical information in the files of the forest experiment stations, the forest schools, and some other agencies. To compile this information systematically and make it available to foresters generally, the Lake States Forest Experiment Station is preparing reports on 15 individual species. Similar reports are being prepared by the other Federal forest experiment stations. When completed, these individual species reports will provide the basis for a comprehensive manual of silvics for the important trees of the United States, to be published by the U. S. Forest Service.

This report is one of the series being prepared by the Lake States Station. A preliminary draft was reviewed by several members of our own Station staff and by a number of well qualified staff members of other forest experiment stations, colleges, and universities; Federal, State, and Provincial forestry organizations; and forest industry. Their comments helped the author to make this report more complete, more accurate, and more up to date.

Every effort has been made to ensure the accuracy and completeness of the information concerning the silvical characteristics of each species consistent with a brief treatment of the subject. We shall appreciate it, however, if any errors or omissions of important information are brought to our attention.

M. B. Dickerman

M. B. Dickerman, Director

Cover: Mature balsam poplar trees 16 to 20 inches in diameter and about 100 years old; these trees originally stood in a white spruce-balsam fir-paper birch type, which was logged over; Koochiching County, Minn. Drawing represents leaves.

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SILVICAL CHARACTERISTICS OF BALSAM POPLAR

(Populus balsamifera L.)

by

Eugene I. Roe
Lake States Forest Experiment Station[1/]

Balsam poplar is a medium-to-large deciduous forest tree composed of two varieties, the typical one, Populus balsamifera var. balsamifera, and P. balsamifera var. subcordata Hylander. For years, this scientific name was applied to both balsam poplar and eastern cottonwood in the belief that they were a single species. When it became evident that they were distinct, P. balsamifera L. was restricted to balsam poplar and the cottonwood given the name, P. deltoides Bartr. Balsamifera is a particularly apt name, referring to the fragrant, balsam-like odor of the sticky buds.

Other scientific names which have been used at various times to denote this tree are P. tacamahaca, P. candicans, P. balsamifera var. candicans, and P. balsamifera var. michauxii. Common names also used are balm, bam (Minnesota and Michigan),[2/3/] tacamahac, tacamahac poplar, black poplar (Saskatchewan), and balm-of-Gilead. The last, however, is more correctly applied to the balm-of-Gilead poplar, an ornamental clone of uncertain origin widely planted in the Lake States and the Northeast. (16, 20).[4/]

1/ Maintained by the Forest Service, U. S. Department of Agriculture, at St. Paul 1, Minnesota, in cooperation with the University of Minnesota.

2/ Correspondence with Scott S. Pauley, School of Forestry, University of Minnesota, May 23, 1956, on file at Lake States Forest Experiment Station.

3/ Correspondence with M. W. Day, Dunbar Forest Experiment Station, Michigan State University, July 6, 1956, on file at Lake States Forest Experiment Station.

4/ Underlined numbers in parentheses refer to literature cited, page 14.

DISTRIBUTION

Balsam poplar, like quaking aspen, is transcontinental in its distribution. It occurs from Newfoundland and Labrador west along the northern limit of tree growth to Yukon territory and northwestern Alaska, thence south to the Alaska range and (mostly on the north or east sides of the Continental Divide) northern and eastern British Columbia, and east through Alberta to northern North Dakota, Minnesota, southern Michigan, southern New York, western Massachusetts and Maine. In addition, it is found locally on Kodiak Island, in southeastern Alaska, northern Idaho, the Black Hills, northwestern Nebraska, the Chicago area, northern and southeastern Ohio, West Virginia, northern Delaware and northern New Jersey, and possibly in western Montana, Yellowstone Park, and Colorado (fig. 1). Variety subcordata occurs from Newfoundland to Ontario and south to northern Michigan, New York, and Maine (16).

Balsam poplar is a distinctly northern tree; it makes its best growth and development in western and northwestern Canada, particularly in the valleys of the Mackenzie, Peace, Liard, and the lower part of the Athabaska rivers. It forms dense forests in the Mackenzie District thousands of square miles in extent (20, 30).

The commercial range[5/] of the tree is imperfectly known. From present knowledge as to the species' development to usable size and its frequency of occurrence, the commercial range (fig. 1) is believed to extend in a rather narrow strip from western New Brunswick through the northern New England States, northern New York, and southern Quebec. The strip then broadens to include the northern part of the Lake States and southern Ontario, then extends northwestward through central Manitoba, northern and central Saskatchewan and Alberta, the northeastern part of British Columbia, and south central Northwest Territories (11, 30).[6/]

5/ Commercial range is defined as that portion of the botanical range within which the species grows to commercial size and is a major or important species in the type.

6/ Correspondence with I. C. M. Place, Department of Forestry and Wildlife Management, University of Wisconsin, March 1, 1956, on file at Lake States Forest Experiment Station.

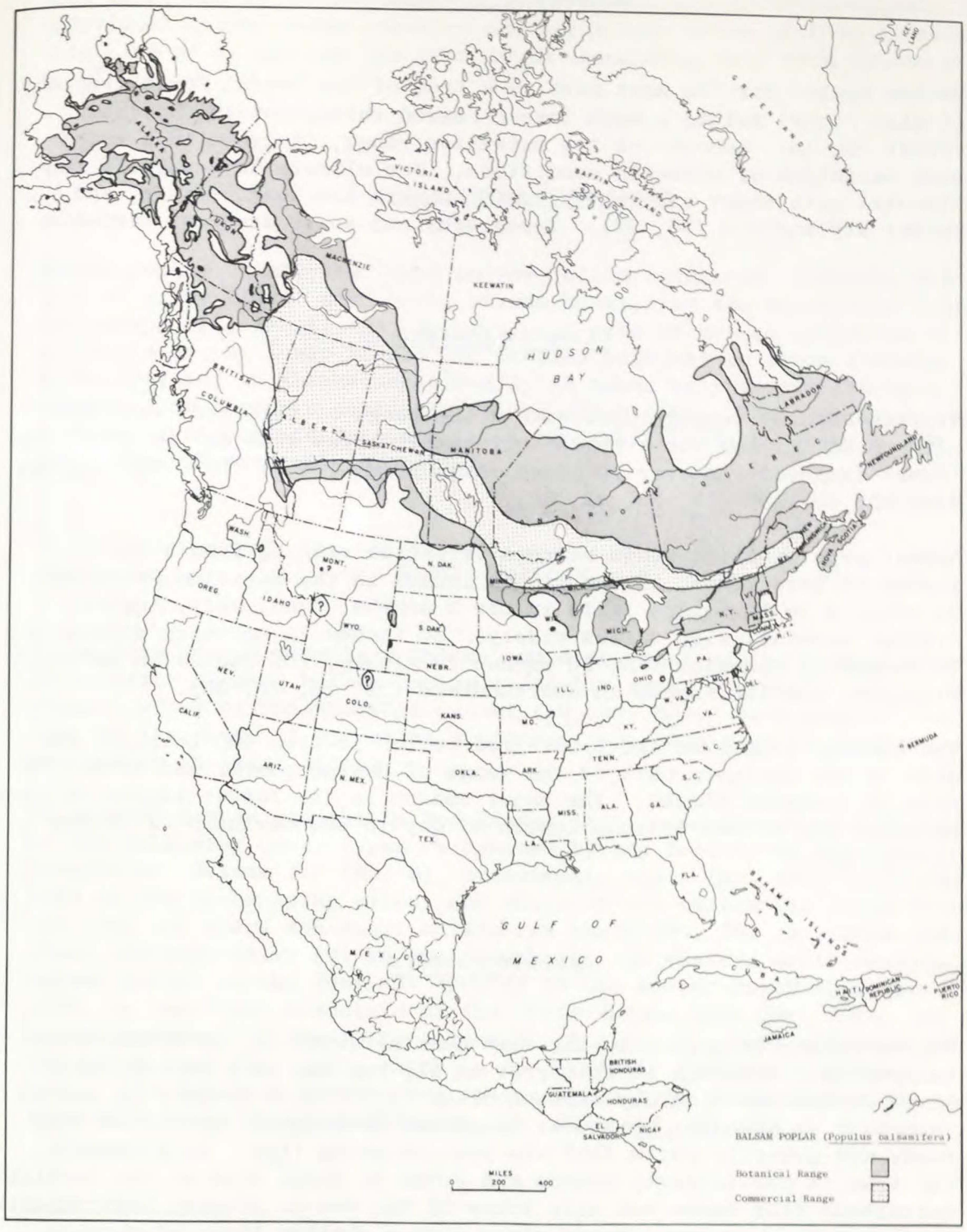


Figure 1.--Botanical and commercial range of balsam poplar.

HABITAT CONDITIONS

Balsam poplar for the most part is a tree of the Boreal Forest region; it also occurs but to a much lesser degree throughout the Northern Forest region. Because of its extensive range, it grows in a rather wide variation of climatic conditions. The climate is generally continental with short and fairly humid summers and long, severe, and rather dry winters (36, 37). Topography and soils are less variable.

Climatic Factors

Average January temperatures within the range of this tree vary from -22° to 25° F. and the average July temperatures from 53° to 75°. The lowest temperatures ever recorded range from -10° to -79°, the highest from 85° to 110° (12, 26, 32, 38).

Annual precipitation shows extreme variation ranging from a low of 7 inches at Fort Yukon, Alaska, to 55 inches in the Maritime Provinces. Of this, 3 to 12 inches falls in the 3 months, June, July, August. Average snowfall also varies widely: 30 inches in northern Minnesota, 40 inches in Saskatchewan, 50 inches in Alaska, 100 inches in northern Michigan, and 160 inches in Newfoundland (12, 26, 32, 38).

The average length of the frost-free period is from 100 to about 160 days in the southern part of the range of balsam poplar and 75 to 120 days in interior Alaska. The short season in the latter region is compensated for by the extreme length of day in the northern latitudes (7, 12, 13).

Edaphic Factors

Balsam poplar is more exacting than quaking aspen in its moisture requirements. Although it will grow on all but the very wettest soils, it is seldom found on dry exposed sites (21). Soil texture is not as important as abundant moisture; excellent development occurs on deep sandy and gravelly soils that are sub-irrigated (10). In Minnesota, the tree is particularly common and grows to large size on the fertile, calcareous clay loams and silt loams of the bed of glacial Lake Agassiz; it also occurs on some swampy sites with a shallow layer of organic soil, but not on deep peats. In northwestern Ontario, balsam poplar is found on moist alluvial soils, lacustrine deposits, and heavy-textured tills with a calcareous C horizon. On most heavy soils in

that area, the A_1 horizon usually shows a distinct crumb structure, the individual crumbs being cohesive and about 1/10 of an inch in diameter; this kind of A_1 horizon has been found associated only with balsam poplar.[7/]

Physiographic Conditions

Balsam poplar usually is found on low, often inundated, alluvial bottoms or river flats, sand bars, stream banks, and the borders of lakes and swamps (18, 19, 21, 25, 30, 37). It also occurs as scattered individuals on the lower slopes and benches adjacent to these lowland sites (34) and in Alaska occasionally is found as stands which have seeded in on burns on decidedly upland sites (18). The tree grows over a range of elevations from sea level (Kodiak Island) to about 5,500 feet (Rocky Mountains) (36, 37).

Biotic Factors

In western and northwestern Canada and along most of the larger rivers in interior Alaska, balsam poplar typically grows in fairly pure stands, often of considerable extent (18, 25, 30). Over much of the rest of its range it occurs as scattered individuals or in groups, occasionally in small stands.

In eastern Canada and the United States it is a component as indicated of the following cover types recognized by the Society of American Foresters: Balsam fir (No. 5), occasional; aspen (No. 16), important only on the lower-lying sites; and white spruce-balsam fir-paper birch (No. 36) and black ash-American elm-red maple (No. 39), a rather constant representative but in small numbers. In western North America, balsam poplar is the dominant species in the poplar-birch type (No. 203), an important associate of the white spruce type (No. 201), and a minor component of the white spruce-birch type (No. 202) and also of the aspen type (No. 217), which is ecologically similar to poplar-birch. In interior Alaska, the poplar-birch type forms a transitional type with black cottonwood-willow (No. 222) (18, 25, 34).

7/ Correspondence with D. W. MacLean, Forestry Branch, Canada Department of Northern Affairs and National Resources, February 17, 1956, on file at Lake States Forest Experiment Station.

The more common trees associated with balsam poplar are white spruce (Picea glauca), black spruce (P. mariana), balsam fir (Abies balsamea), northern white-cedar (Thuja occidentalis), quaking aspen (Populus tremuloides), paper birch and its Alaska and Kenai varieties (Betula papyrifera and vars. humilis and kenaica), black ash (Fraxinus nigra), American elm (Ulmus americana), and red maple (Acer rubrum) (7, 18, 34). Occasional tree associates are tamarack (Larix laricina), Engelmann spruce (P. engelmannii), eastern white pine (Pinus strobus), sugar maple (Acer saccharum), silver maple (A. saccharinum), boxelder (A. negundo), basswood (Tilia americana), yellow birch (Betula alleghaniensis), bur and northern red oaks (Quercus macrocarpa and Q. rubra), green ash (Fraxinus pennsylvanica), white ash[8/] (F. americana) and in Alaska, black cottonwood (Populus trichocarpa), Sitka and thinleaf alders (Alnus sinuata and A. tenuifolia), and feltleaf, Bebb, littletree, and Scouler willows (Salix alaxensis, S. bebbiana, S. arbusculoides, and S. scouleriana) (7, 18, 25, 34).

Many shrubs are associated with balsam poplar, the most common ones being: speckled alder (Alnus rugosa), American green alder (A. crispa), redosier dogwood (Cornus stolonifera), bunchberry dogwood (C. canadensis), mountain maple (Acer spicatum), beaked hazel (Corylus cornuta), American cranberrybush (Viburnum trilobum), mooseberry (V. pauciflorum), red raspberry (Rubus idaeus vars. canadensis and strigosus), American red currant (Ribes triste), prickly rose (Rosa acicularis), and mountain cranberry (Vaccinium vitis-idaea var. minus) (7, 18, 21, 25).[9/] None of the great variety of herbaceous plants found under balsam poplar are known to be characteristic of this species alone. Nor are any of the birds and mammals found in the Boreal and Northern Forest regions associated exclusively with balsam poplar. Animals known to affect the life and development of this tree are discussed under factors limiting the growth of saplings to maturity.

8/ Place: See footnote 6, page 2.

9/ Unpublished data, Lake States Forest Experiment Station.

Seeding Habits

Flowering and Fruiting

The unisexual flowers of balsam poplar are borne in catkins, male and female on different trees, and mature in April to May before the leaves appear (39). In Marquette County, Mich., 4 years of records show that the average date for flowering to begin is May 2 with full bloom reached on May 9; the average date for swelling of leaf buds is May 2 (5-year record), beginning of leaf formation May 13 (8 years), and full leaf June 10 (9 years).9/

The capsules bearing the seed mature during May or June when the leaves are about two-thirds grown.10/ Seed dispersal occurs immediately thereafter. This is reported as May to June in Minnesota (28). It has been observed in late June in northern Wisconsin and in the first week of July in northeastern Minnesota and the Upper Peninsula of Michigan.9/11/ In the western part of the range, seed dispersal probably occurs in June and July.

Three years' records in Marquette County, Mich., show that the average date for leaf coloration to begin is September 8, that of maximum coloration October 5; leaf fall begins September 10 and is completed October 5.9/

Seed Production and Dissemination

No data are available as to the age or size of the tree when seed production begins, the frequency of seed crops, and the amount of seed produced. However, the tree is said to produce seed nearly every year (10) and in great quantities (18). The seed is provided with long white hairs and is consequently carried long distances by wind.

9/ Unpublished data, Lake States Forest Experiment Station.
10/ Pauley: See footnote 2, page 1.
11/ Day: See footnote 3, page 1.

Vegetative Reproduction

In addition to reproducing from seed, balsam poplar also regenerates vegetatively from root suckers like the aspens, from stump sprouts, and from cuttings. Suckers appear late in the summer following cutting and grow very rapidly, sometimes outgrowing those of quaking aspen.[11/] Suckering is the general method by which this tree reproduces in Alberta (21). In Alaska, suckers are much more important than seed in restocking fire-killed stands of this species; reproduction from seed is important in the colonization of areas where the tree did not occur before, such as freshly exposed alluvium or upland burns (18). Stump sprouting is probably not very effective, for the sprouts usually break off at an early age (6). The tree can be propagated easily from root or stem cuttings (9, 35).[11/12/13/]

Seedling Development

Balsam poplar seed is not dormant and appears to germinate immediately after dispersal (May to early July) if seedbed conditions are favorable. If conditions are unfavorable the seed dies, for its viability will be retained for only a few days unless given special storage conditions (22).

Balsam poplar seedlings are epigeous in germination habit (39). They are very delicate and require ample moisture during the germination period. Moist mineral soil, such as recently deposited alluvium along streams and valleys subjected to overflow or soil exposed by recent fires, furnishes an excellent seedbed (18). For best establishment of seedlings, the seedbed should probably be continuously moist for a week or two as in nursery seedbeds (6, 39). Like those of other species of Populus, balsamifera seedlings doubtless are very susceptible to damping-off, heat, and drought.

11/ Day: See footnote 3, page 1.

12/ Pauley: See footnote 2, page 1.

13/ Correspondence with E. J. Schreiner, Northeastern Forest Experiment Station, U. S. Forest Service, March 22, 1956, on file at Lake States Forest Experiment Station.

Sapling Stage to Maturity

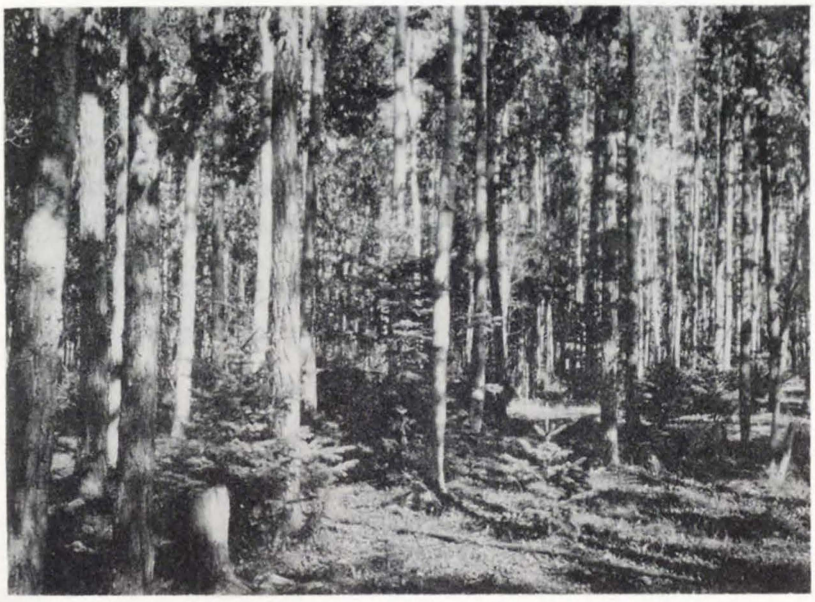
Growth Rate and Sizes Attained

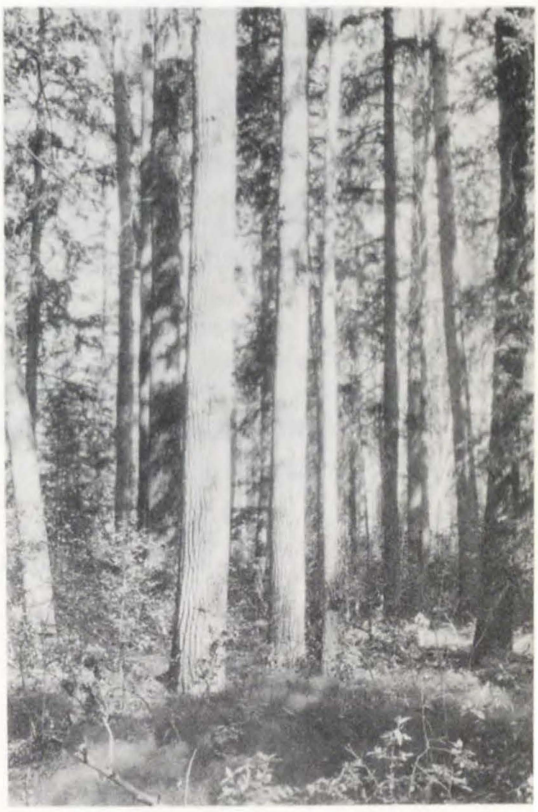
Balsam poplar grows rapidly in height and diameter during its first 40 to 50 years; trees of this age range from 14 to 18 inches in diameter and up to 85 feet in height (36, 37).[14/] In Alberta, it grows faster than quaking aspen on the better sites and rarely is found on any areas with a site index less than 55. The tree is not long lived, but it lives longer than quaking aspen and eventually dominates sites stocked with a mixture of the two species (21).

The tree reaches its maximum size along the Mackenzie River in northwestern Canada where it reaches heights of 80 to 100 feet and diameters at breast height (d.b.h.) of 3 to 7 feet (30, 37). In Alberta, it does not get as large in diameter; although Moss (21) lists a 135-year-old tree which was 43 inches d.b.h. (but 118 feet in height), trees of this age more commonly average 30 inches d.b.h. and those 70 years old, 18 inches. In Saskatchewan, balsam poplar grows to 3 to 4 feet in diameter (31); in Alaska 3 feet and larger in d.b.h. and 75 feet high (18). In the United States, mature trees average 60 to 70 feet in height (infrequently 80 feet) and 12 to 30 inches, sometimes 40 inches, d.b.h. (28, 30, 37) (fig. 2). Balsam poplar has a narrow, open crown made up of a relatively few stout, mostly ascending branches. It usually has a shallow root system (4).

14/ See footnote 9, page 6.

Figure 2.--Left: Balsam poplar-aspen cummunity with vigorous young white spruce in Alberta. Right: Balsam poplar-spruce stand in Alberta; poplars 135 years old and about 110 feet tall; ground cover mainly Hypnum-Hylocomium mosses and Equisetum. (Photos courtesy Prof. E. H. Moss, University of Alberta.)





Little information is available on the yield of balsam poplar stands. Day and Vogel (6) state that well-stocked mature stands may contain as much as 10 to 15 M feet of sawlogs per acre. Pulpwood yields are estimated to average 10 to 20 cords per acre at 45 to 50 years of age.[14/] In Alaska stands may be even aged or show a considerable range in age; they have a high density of 3,500 trees per acre at 25 years of age, 700 stems at 100 years, 500 at 150 years, but only 90 stems at 200 years. Corresponding basal areas for trees 2 inches or larger in d.b.h. were 8, 163, 171, and 144 square feet per acre respectively (18). In Upper Michigan, density seems to run lower, a stand of 15-year-old suckers averaging 740 trees per acre with a basal area of 27 square feet.[15/]

The tree is rather short lived in this country but longer lived in the northern parts of its range. Trees over 135 years of age are rare in Alberta (21), but others up to 200 years of age have been reported for the Rocky Mountain region and Alaska (18, 37).

Reaction to Competition

Balsam poplar is less tolerant of shade than its common associates, white spruce, balsam fir, northern white-cedar, black ash, and red maple, but about equally as intolerant as quaking aspen and paper birch. It will not grow in competition with other species unless it is dominant (6). It sometimes forms dense stands under old trees, but will eventually die out unless given full top light (37). Balsam poplar prunes itself better than all but its more intolerant associates; trees clear of branches for 30 to 50 feet are not uncommon (37).

Place in Succession

Within at least the far northern parts of its range, balsam poplar is the first important tree to invade such recently deposited soils as sand bars and other alluvium along streams subject to overflow (7, 18, 25). It occasionally will seed in from its more characteristic lowland habitat on fresh burns on adjacent upland; such sites, however, are more likely to be invaded by aspen or paper birch (18).

Its suckers also become dominant on burned areas of the poplar-birch type or of other types, such as the white spruce type, in which the tree is a common associate (18, 34). In Alberta, balsam poplar invades aspen stands and gradually becomes dominant because of its longer life,

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14/ See footnote 9, page 6.
15/ Day: See footnote 3, page 1.

only to be succeeded by the climax forest of white spruce (21, 25). On some areas in Alaska balsam poplar stands are replaced eventually by white spruce; on others, such as flood plains subject to periodic flooding and soil deposition, the tree appears to be climax (18).

In the southern part of the range, stands of balsam poplar usually open up with age and are eventually succeeded by stands of tolerant and usually longer-lived species such as white spruce, balsam fir, northern white-cedar, black ash, and American elm (34).[16/]

Limiting Factors

Compared to many of its associates, balsam poplar has few enemies; those causing appreciable injury or death of trees in the sapling to mature stages are described below:

1. Young trees have relatively thin bark and are easily killed by fire. Mature trees, however, have bark as much as 4 inches thick at the base of the bole. This, coupled with the fact that fires in balsam poplar stands are usually light because of the characteristically low amount of fuel, makes old trees quite resistant to fire injury (18). Aside from its injurious aspects, fire may be considered of benefit in that it helps perpetuate the species. Fire-killed trees sucker abundantly from their shallow roots, and a new stand generally follows. Fire also improves seedbed conditions for balsam poplar on upland sites which, if unburned, could not be invaded by its seedlings (18).

2. Trees along the banks of the northern rivers are subject to undermining and uprooting during flood stages (30).

3. The forest tent caterpillar, Malacosoma disstria, will feed on the foliage of balsam poplar, but only when that of preferred species in the same stand such as quaking aspen has been completely destroyed.[17/]

4. The poplar and willow borer, Cryptorhynchus lapathi, an introduced weevil is the most serious insect pest of this tree.[17/] It causes considerable mortality in sapling and small pole stands.[18/]

16/ See footnote 9, page 6.

17/ Correspondence with Samuel A. Graham, School of Natural Resources, University of Michigan, dated 1956, on file at Lake States Forest Experiment Station.

18/ Day: See footnote 3, page 1.

5. An unknown species of lace bug (Tingidae) occasionally feeds on the leaves. Balsam poplar commonly exudes large amounts of sap when injured; this characteristic probably is a deterrent to serious insect attack of the leaves and twigs.[19/]

6. The poplar borer, Saperda calcarata, attacks the tree in New England (24).[20/]

7. A leaf spot caused by Mycosphaerella populorum (Septoria musiva) attacks the leaves, but since the browning caused does not become severe until late in August the disease probably has little effect on growth (5). This same fungus also causes a destructive canker disease on hybrid poplars with balsam poplar parentage but does not cause canker on balsam poplar within its natural range (42).

8. Leaf rusts caused by various species of Melampsora are also common on seedlings in the nursery.[21/]

9. Heart rot caused by Fomes igniarius and butt rot by Armillaria mellea are common types of decay in balsam poplar in the Lake States (17) and probably throughout its range. In Alberta, although all old trees show more or less decay, balsam poplar is considered less susceptible to wood-rotting fungi than is quaking aspen (21).

10. The canker caused by Hypoxylon pruinatum, which is responsible for so much mortality in quaking aspen, causes but little loss in balsam poplar (3, 5).

11. Snowshoe hares (Lepus americanus) often girdle the bark of young saplings, either killing or deforming them.[19/]

12. Moose (Alces alces) browse heavily on balsam poplar saplings during the winter months (14).

13. White-tailed deer (Odocoileus virginianus) browse the twigs and leaves of young saplings to a slight extent in the fall (1) but prefer quaking aspen if it is available.[22/]

14. Beaver (Castor canadensis) frequently cut down balsam poplars and eat the bark.

15. Ruffed grouse (Bonasa umbellus) eat the buds and developing catkins (8, 40).

19/ See footnote 9, page 6.
20/ Schreiner: See footnote 13, page 8.
21/ Place: See footnote 6, page 2.
22/ Graham: See footnote 17, page 11.

SPECIAL FEATURES

Balsam poplar has soft weak wood. The heartwood is often very dark and of a disagreeable odor. Many trees have a zone of water-soaked tissue known as wetwood between the heartwood and the sapwood (41). Heartrot and mineral stain are common defects.

The wood is principally used for lumber, the poorer grades (most of the volume) for boxes, crating, and grain doors, and the better grades for roof boards, sheathing, subflooring, and pulp. The better logs occasionally are made into veneer. Small amounts are used for ties and excelsior (2, 6). Balm-of-Gilead, derived from the resinous buds, is used in some cough medicines (15). The thick bark of old trees has been used as a substitute for cork in the net floats of fishermen on the north shore of the Great Lakes (30).

Balsam poplar foliage can be killed by spraying with combined esters of 2,4-D and 2,4,5-T in midseason after growth has hardened (29) and presumably would show even less resistance to earlier applications.

RACES, HYBRIDS, AND OTHER GENETIC FEATURES

Like most species of wide distribution, balsam poplar has developed races. Tests in Massachusetts (23), showed that height growth ceased some 2 months earlier in plants originating in high latitudes (55° to 60° N. Lat.) than in those originating in lower latitudes (44° to 46° N. Lat.). There is a strong possibility that balsam poplars from some portions of Alaska and the western United States represent some intermixture with Populus trichocarpa. There is also an apparent instance of intermixture with P. tremuloides in Ontario.[23/] Hybrids have been reported between balsam poplar and the following species: Populus alba, P. deltoides, P. laurifolia, P. nigra, P. simonii, P. suaveolens, P. tremula, and P. tristis (27). The number of chromosomes in vegetative tissue cells (diploid number) is 38 (19 pairs) in balsam poplar (33).

23/ Unpublished information from Philip N. Joranson, Institute of Paper Chemistry, Appleton, Wis.

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Station Paper 44 - Red pine
Station Paper 45 - Black spruce
Station Paper 47 - Rock elm
Station Paper 49 - Quaking aspen
Station Paper 50 - Sugar maple
Station Paper 52 - Tamarack
Station Paper 54 - American elm
Station Paper 55 - White spruce
Station Paper 59 - Slippery elm
Station Paper 61 - Jack pine
Station Paper 62 - American basswood
Station Paper 63 - Bigtooth aspen

Ensuing reports will cover the following species:

Black maple
Northern white-cedar

SOME RECENT STATION PAPERS

Chemical Control of Brush and Trees in the Lake States.
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